EXPERIENCE WITH TUNING

Joel Susskind, Fricky Keita, and John Blaisdell
NASA GSFC Sounder Research Team

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OVERVIEW

Suggested changes from Version 4.0 to Version 4.2

Tuning experiments using Version 4.2

Experiment with physics error estimate

VERSION 4.2

We have made a number of minor modifications to GSFC Version 4.0

- Include AMSU A channels in combined surface and T(P) retrievals

  were in JPL Version 4.0

- Add 11 IR channels from 727.87 cm^{-1} - 755.33 cm^{-1} to physical T(P) retrieval

  Now 69 channels

- Force at least 3 iterations before terminating constituent profile retrievals

- Eliminate 3 steps from physical retrieval

Based on suggestions by Chris Barnet

VERSION 4.0 STEPS IN PHYSICAL RETRIEVAL

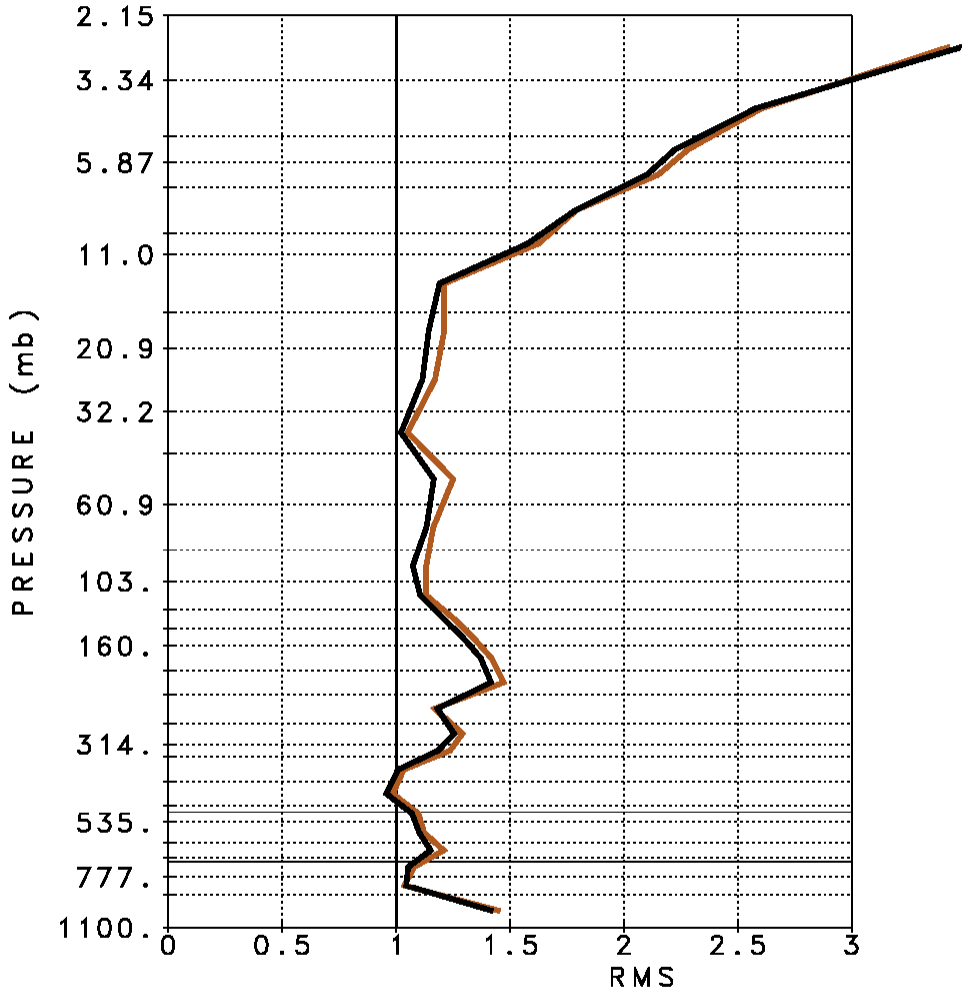
1. AMSU/STRAT IR retrieval - uses MW product
2. Determine $\eta^1, \hat{R}_i^1$
3. Regression - first product using $\hat{R}_i^1$
4. AMSU/STRAT IR retrieval - uses first product
5. Determine $\eta^2, \hat{R}_i^2$
6. AIRS surface retrieval using $\hat{R}_i^2$ – gives $T_s^1 \varepsilon_i^1$
7. AMSU/STRAT IR retrieval using T_s^1
8. Determine $\eta^3, \hat{R}_i^3$
9. AIRS surface, T(P), q(P), O_3(p) retrievals using $\hat{R}_i^3$
10. AMSU/STRAT IR retrieval
11. Determine $\eta^4, \hat{R}_i^4$
12. Repeat surface and T(P) retrievals using $\hat{R}_i^4$

Steps 5-7 have been eliminated in Version 4.2

$\eta, \hat{R}_i$ are computed only 3 times

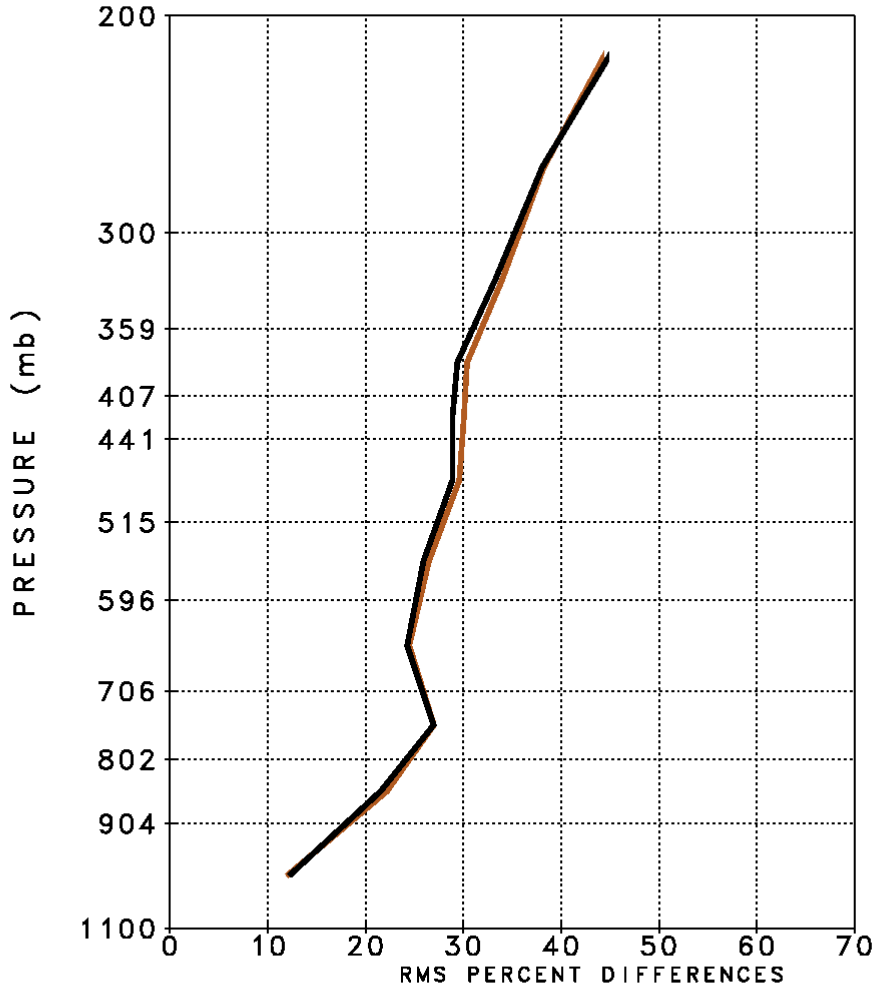
Program runs $\approx$10% faster - results slightly better

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



Stratosphere	Mid Troposphere	Lower Troposphere	
80.44%	45.63%	22.24%	Version 4.0 Baseline
82.75%	49.34%	22.60%	Version 4.2 Baseline

1 Km LAYER PRECIPITABLE WATER DIFFERENCE
January 25, 2003



Mid Troposphere	Lower Troposphere	
45.63%	22.49%	Version 4.0 Baseline
49.34%	22.85%	Version 4.2 Baseline

AIRS TUNING COEFFICIENTS

Form of tuning

$$\left(\hat{\Theta}_i - \hat{\Theta}_i^{comp}\right)' = \left(\hat{\Theta}_i - \hat{\Theta}_i^{comp}\right) + A_i$$

Use $\left(\hat{\Theta}_i - \Theta_i^{comp}\right)'$ in all retrieval steps

A_i derived as the mean of $\left(\hat{\Theta}_i - \Theta_i^{truth}\right)$

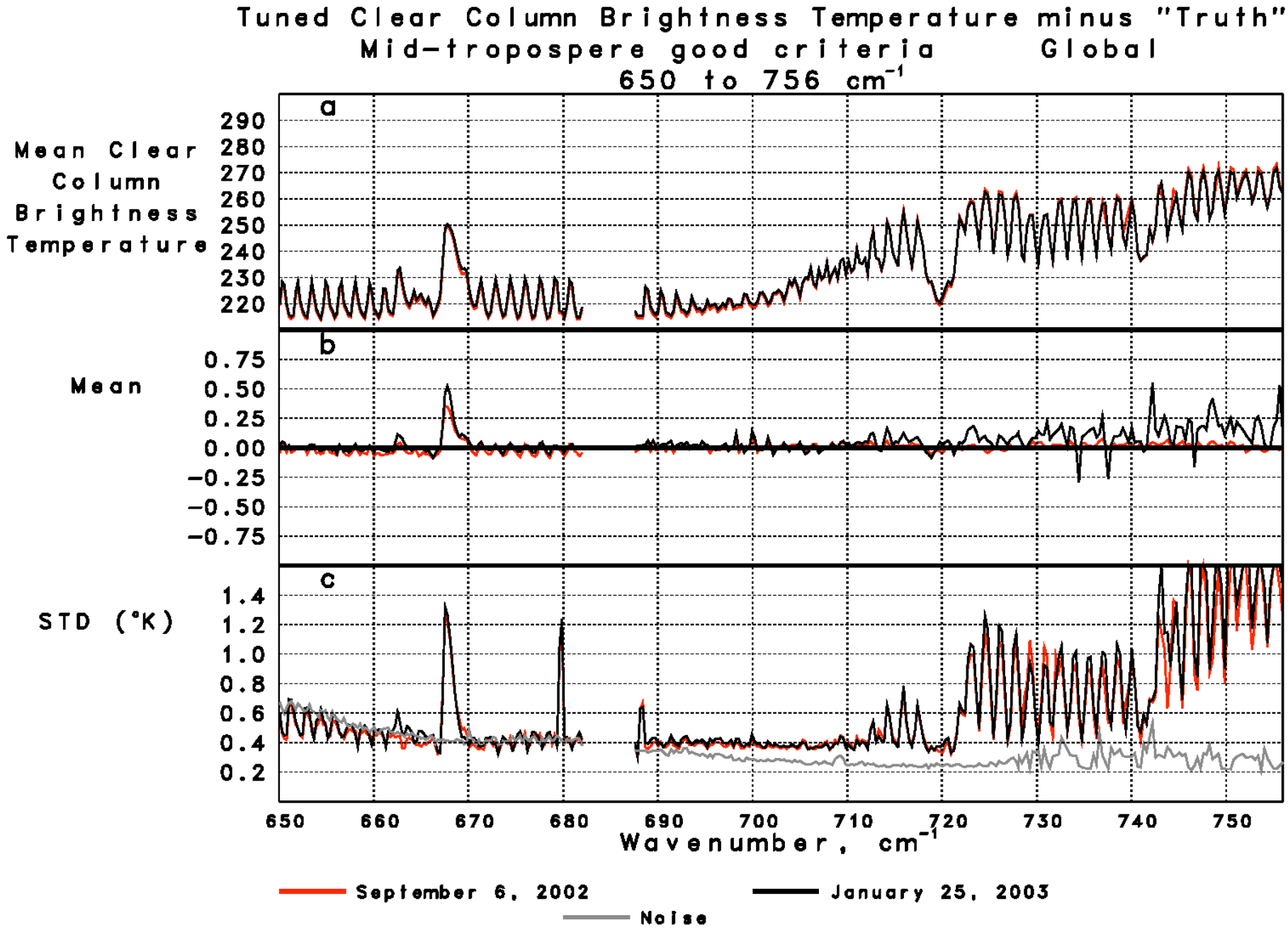
5138 “clear” ocean night cases on September 6, 2002

Colocated ECMWF forecast used to compute Θ_i^{truth}

A_i appears stable over space and time

A_i is used only for channels in the spectral ranges 600 cm^{-1} - 756 cm^{-1} and

2180 cm^{-1} - 2422 cm^{-1}


Tuned Clear Column Brightness Temperature minus "Truth"
Mid-tropospere good criteria Global
650 to 756 cm-1
a
b
c
Mean Clear Column Brightness Temperature
Mean
STD (°K)
290
280
270
260
250
240
230
220
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
1.4
1.2
1.0
0.8
0.6
0.4
0.2
650
660
670
680
690
700
710
720
730
740
750
Wavenumber, cm-1
September 6, 2002
January 25, 2003
Noise

EXPERIMENTS WITH TUNING COEFFICIENTS

Use Version 4.2 with tuning coefficients generated on September 6, 2002

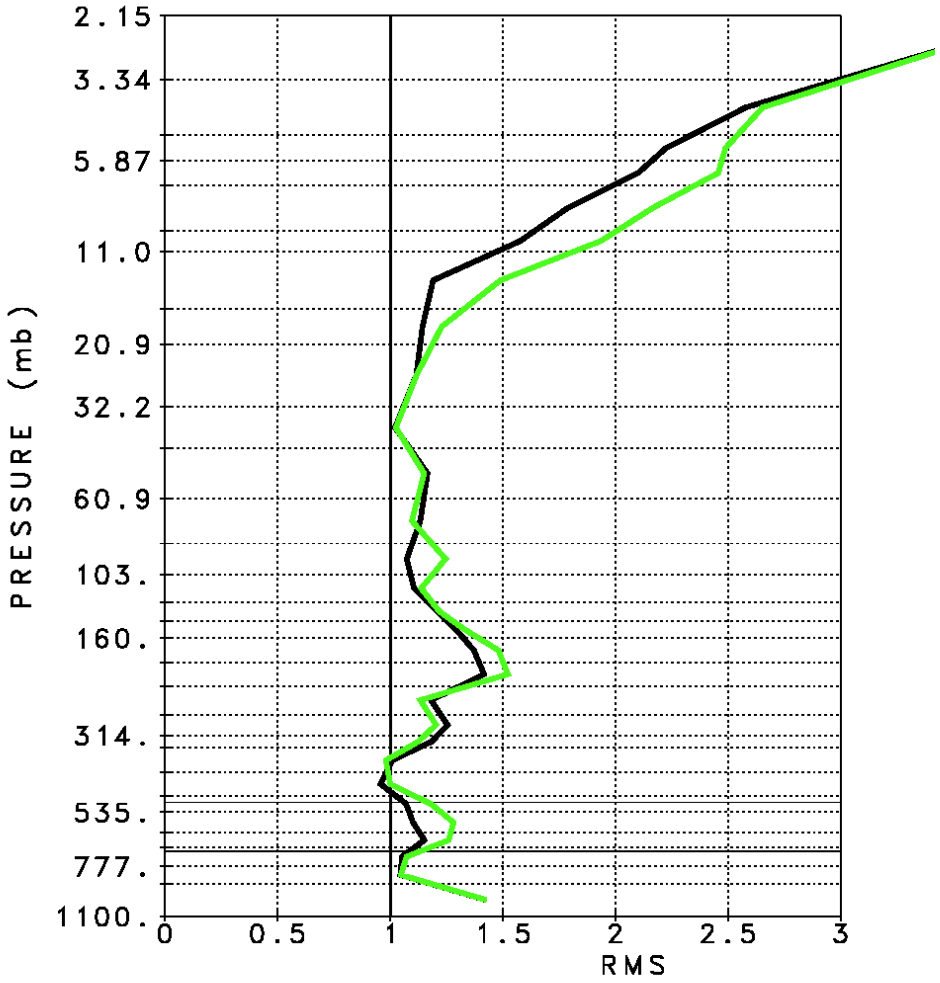
Test on January 25, 2003 and March 6, 2005

Compare with colocated ECMWF forecast

Run retrievals with baseline tuning, no tuning, no 15 μm tuning, no 4 μm tuning

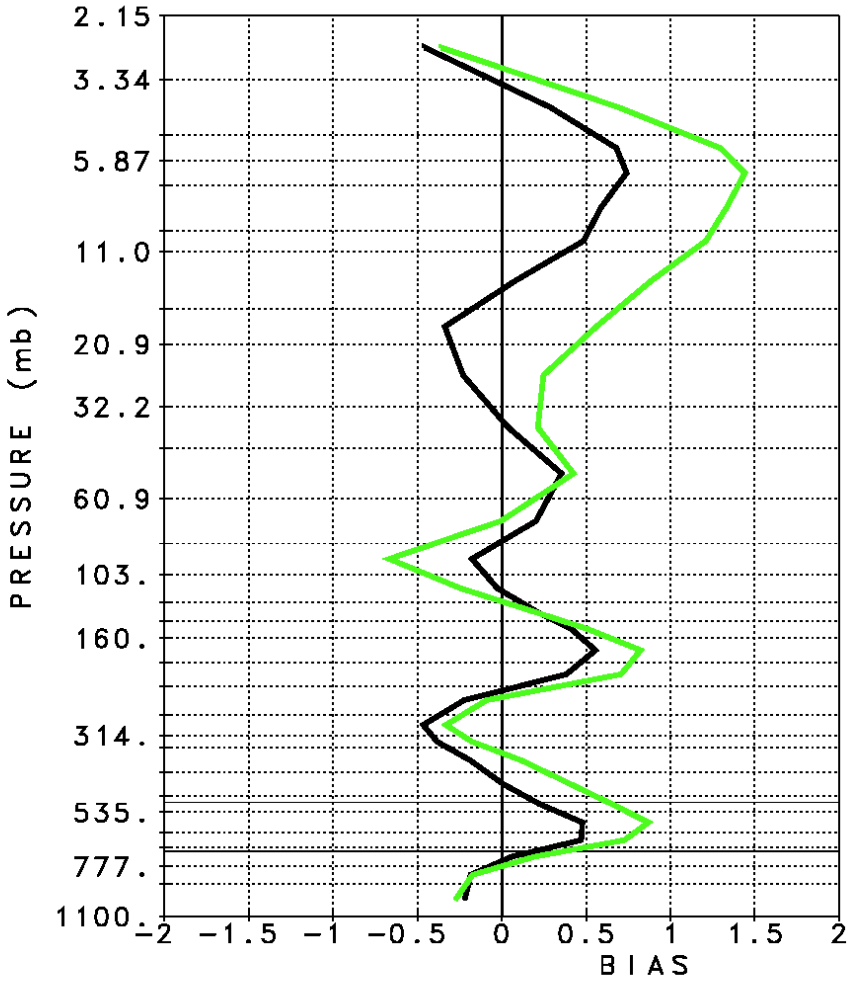
Based on observed results, we ran with 15 μm tuning as is and double 4 μm tuning

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



Stratosphere	Mid Troposphere	Lower Troposphere	
82.75%	49.34%	22.60%	Version 4.2 Baseline
80.06%	47.66%	22.45%	No IR tuning

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



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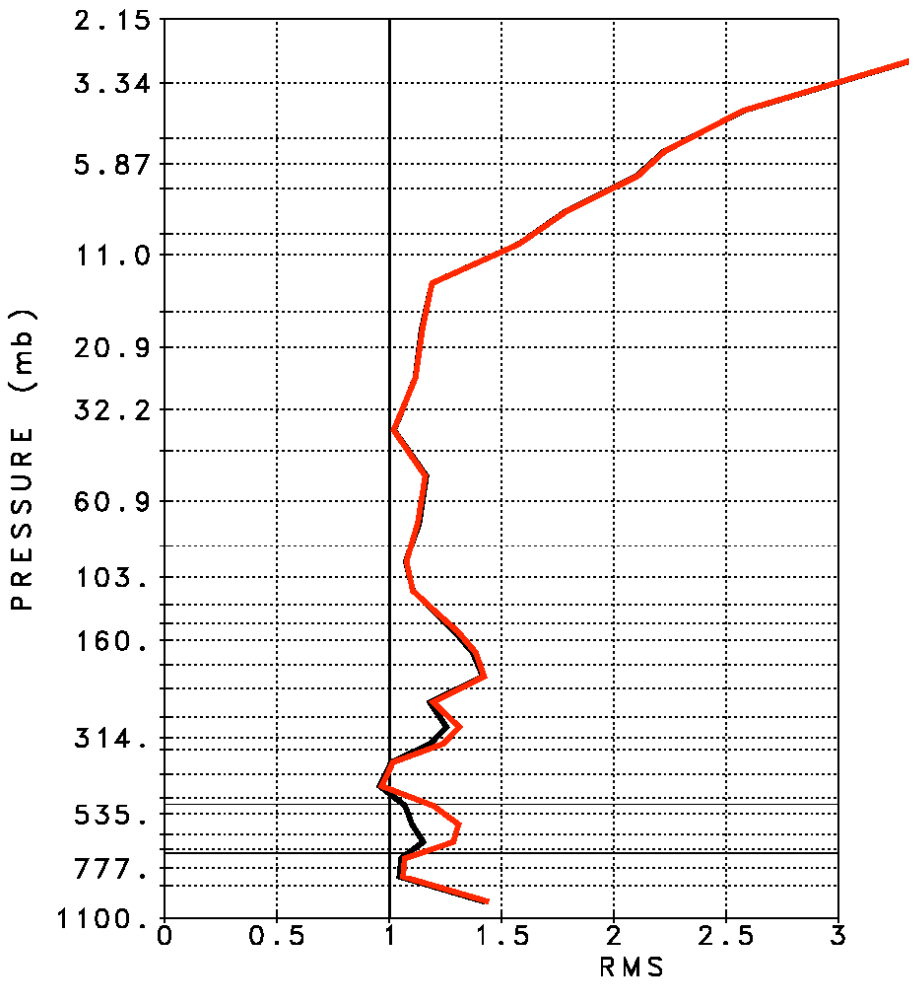
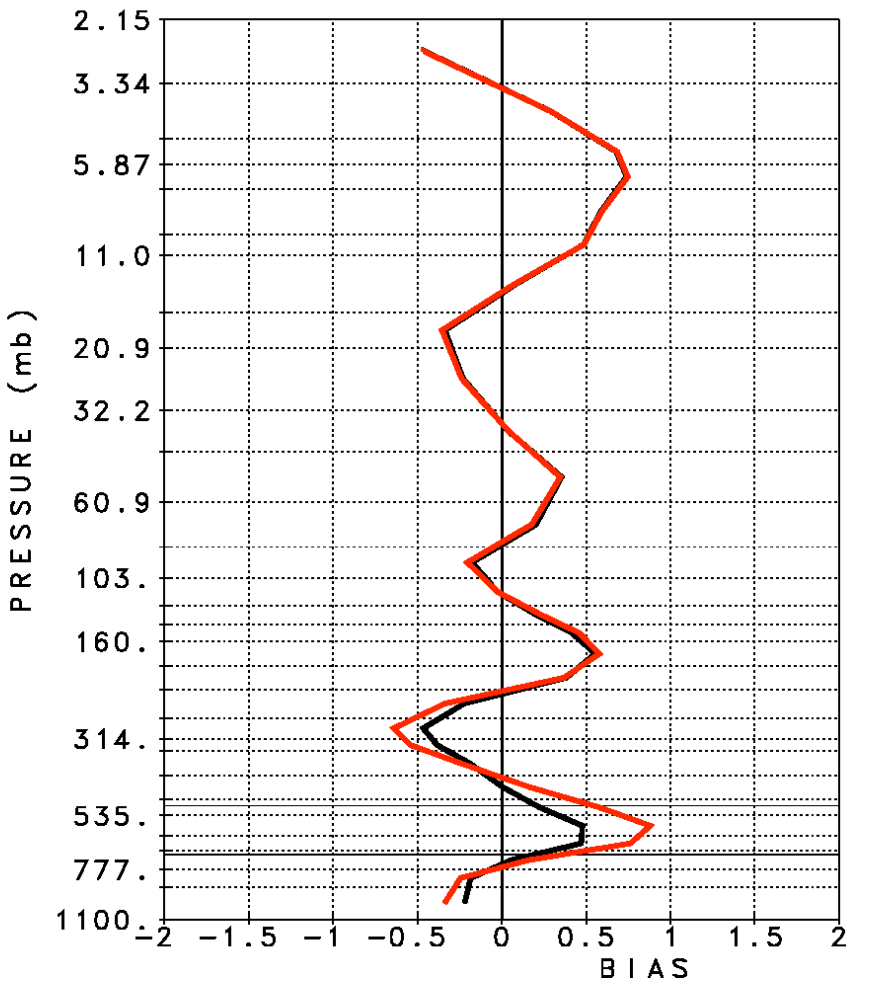
January 25, 2003



Stratosphere	Mid Troposphere	Lower Troposphere	
82.75%	49.34%	22.60%	Version 4.2 Baseline
82.69%	47.69%	22.37%	No SW tuning

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



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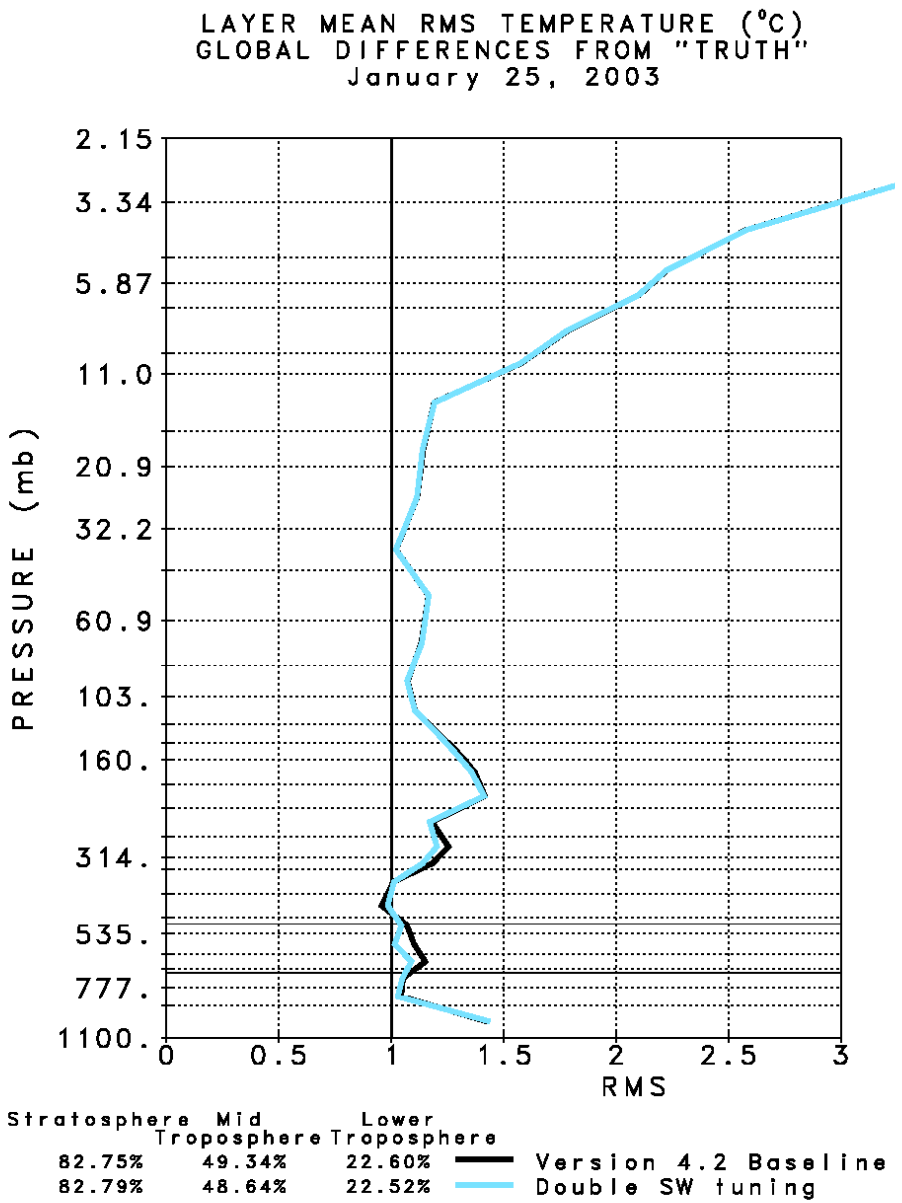
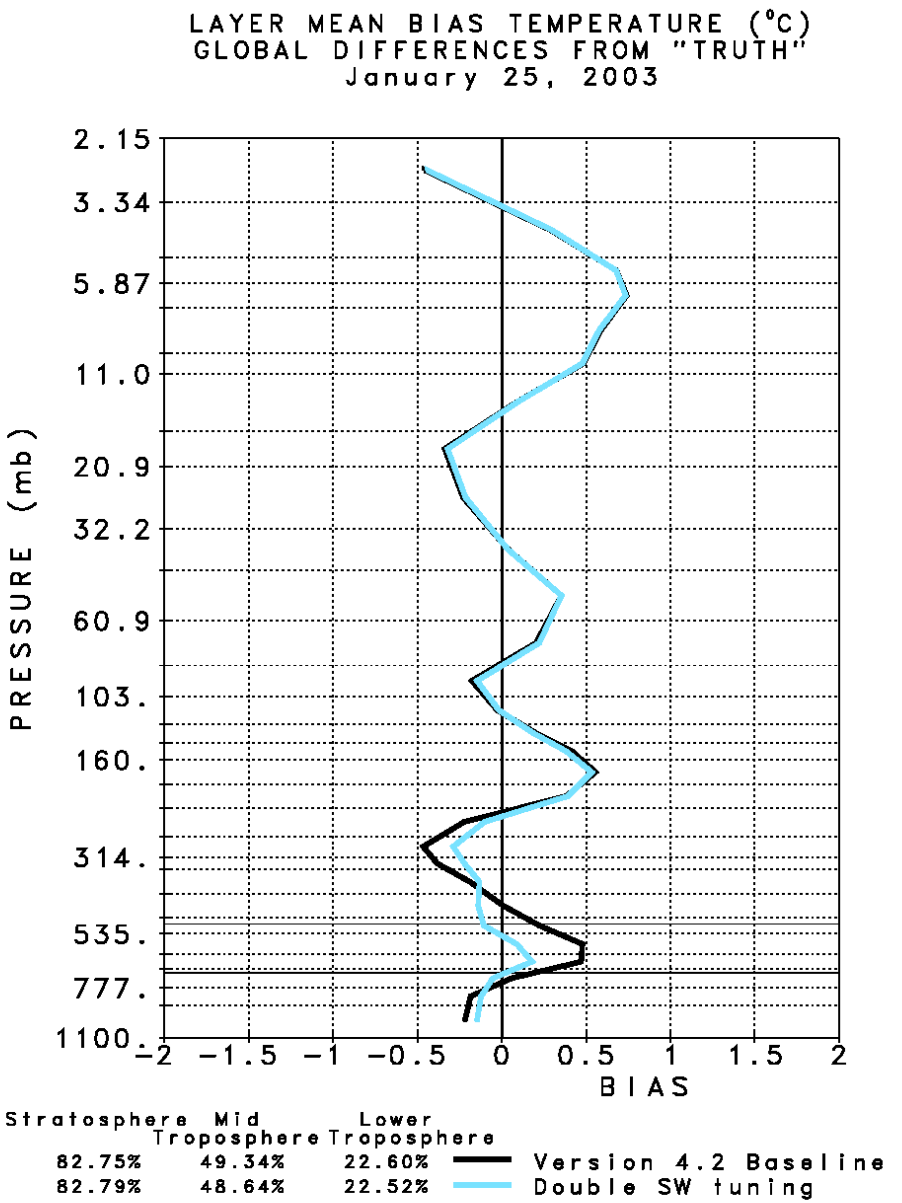

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0
0.5
1
1.5
2
2.5
3
RMS
Stratosphere
Mid Troposphere
Lower Troposphere
82.75%
49.34%
22.60%
Version 4.2 Baseline
82.79%
48.64%
22.52%
Double SW tuning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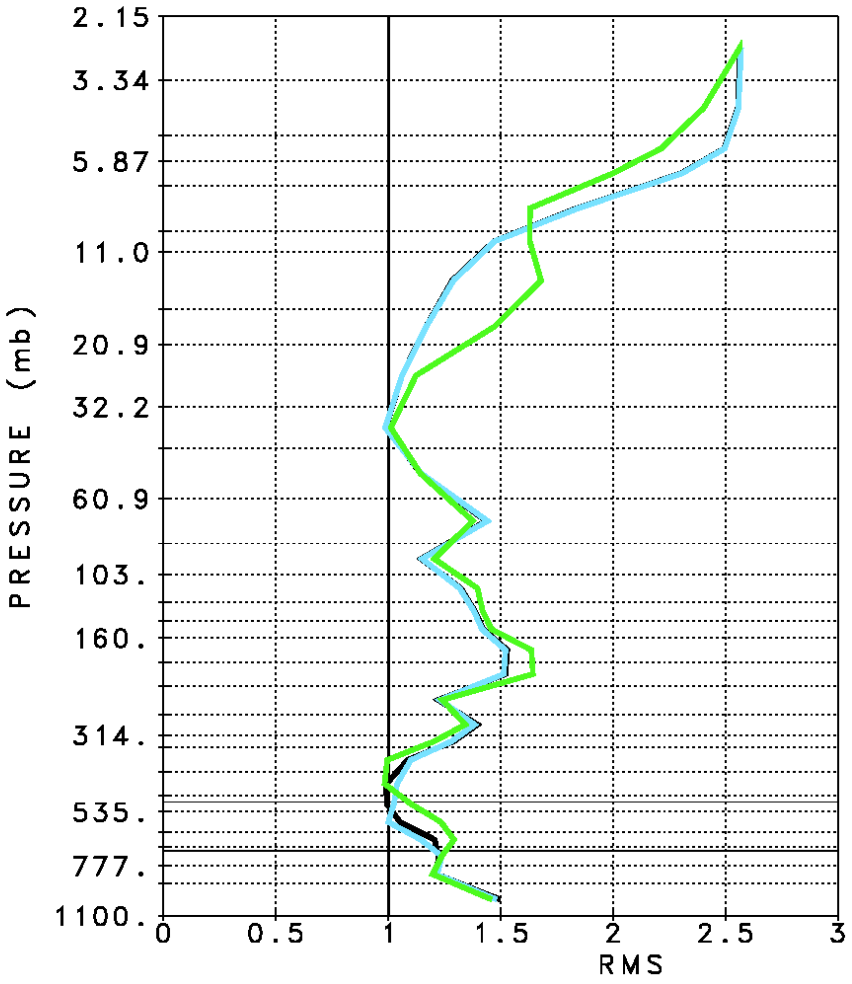
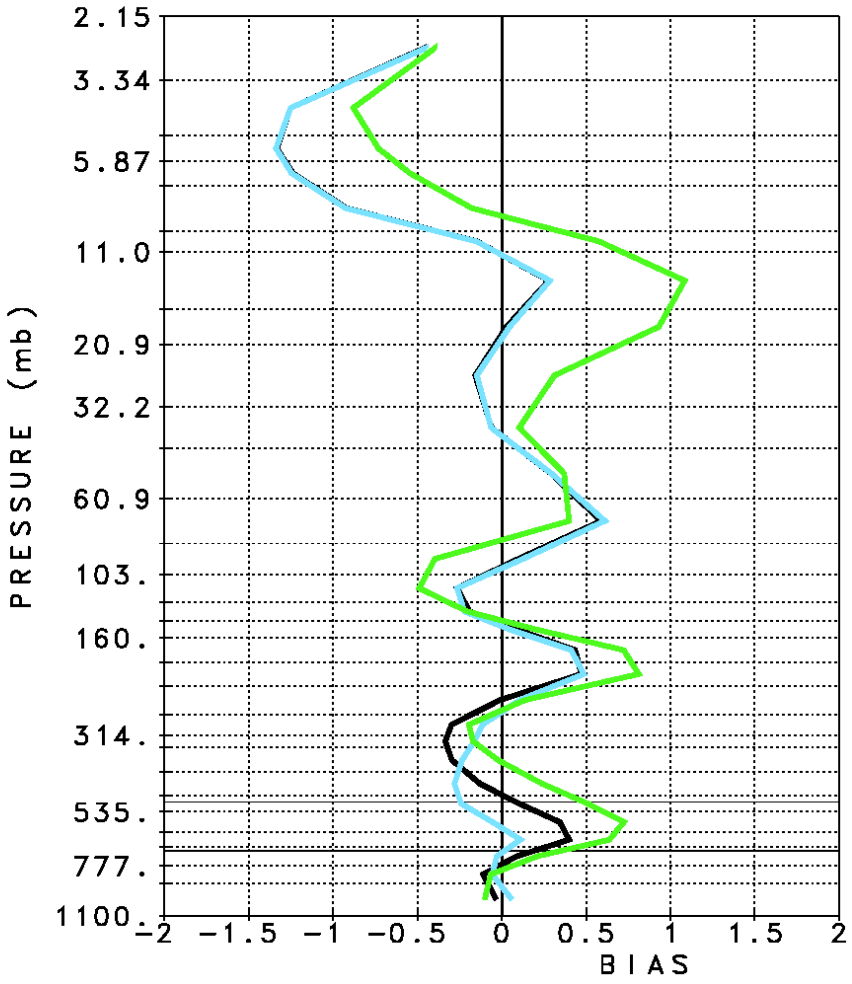
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
BIAS
Stratosphere
Mid Troposphere
Lower Troposphere
82.75%
49.34%
22.60%
Version 4.2 Baseline
82.79%
48.64%
22.52%
Double SW tuning

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
March 6, 2005



Stratosphere	Mid Troposphere	Lower Troposphere	
83.39%	49.67%	22.89%	Version 4.2 Baseline
83.49%	49.33%	22.68%	Double SW tuning
81.26%	49.69%	23.86%	No IR tuning

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
March 6, 2005



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81.26%	49.69%	23.86%	No IR tuning

EXPERIMENT WITH "PHYSICS ERROR" TERM

We currently add a term $\overline{N}_{ii}$ to the diagonal of the channel noise covariance matrix to allow for random physics errors in R_i^{comp}

$\overline{N}_{ii}$ is empirical, and roughly constant at a level of 0.3K

$\overline{N}_{ii}$ as is already includes 0.1K for all channels before adding other terms

Methodology can most likely be improved

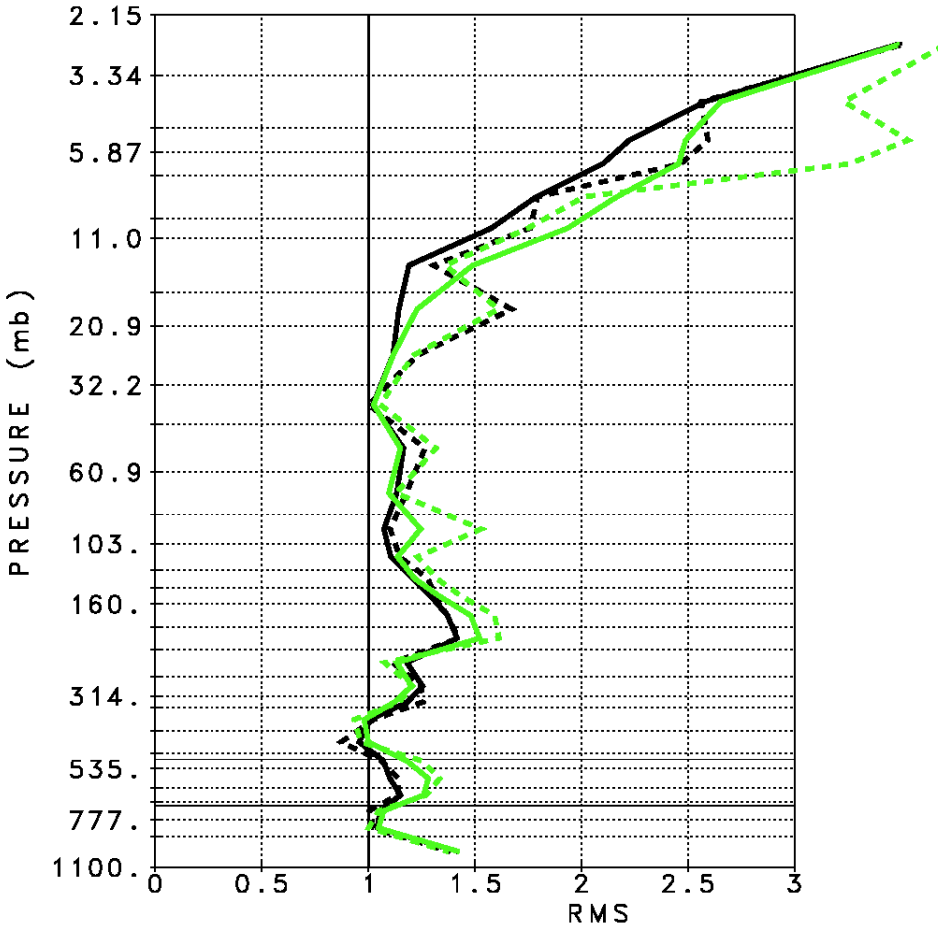
We currently have no $\overline{N}_{ii}$ term reflecting uncertainty of R_i^{comp} due to uncertainty in CO_2 amount

We set $\overline{N}_{ii} = 0$ to all channels and compared results with $\overline{N}_{ii}$ as is

With baseline tuning

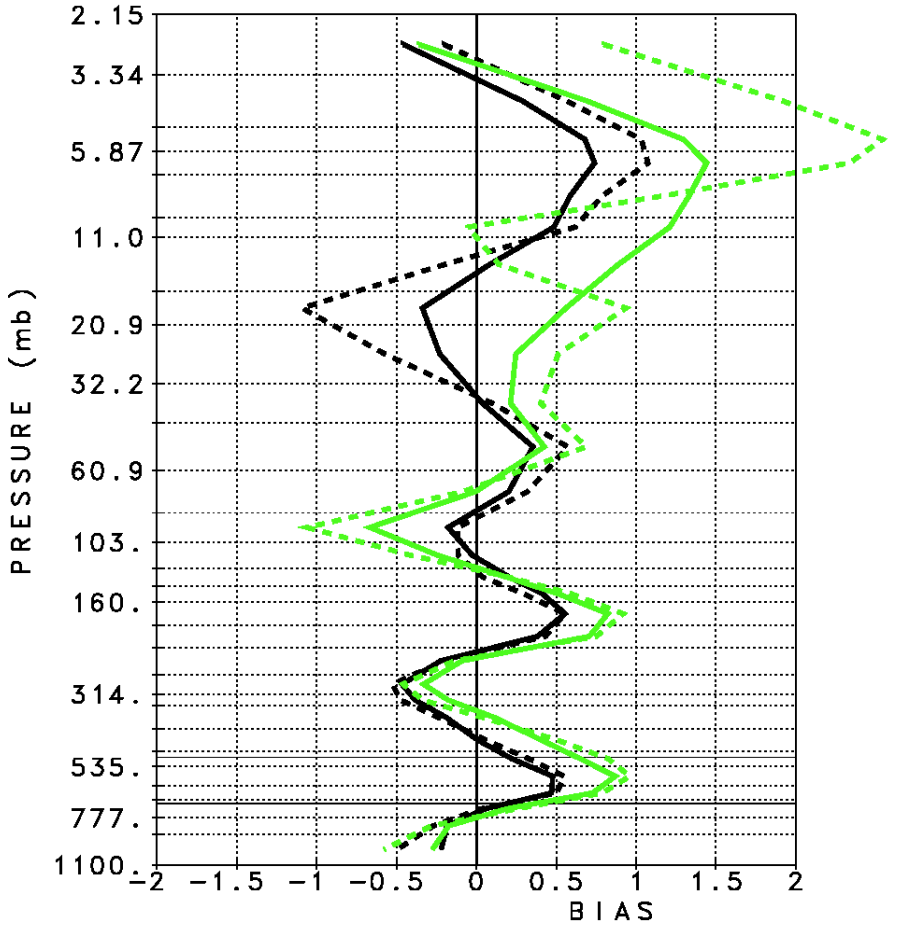
With no IR tuning

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



Stratosphere	Mid Troposphere	Lower Troposphere	
82.75%	49.34%	22.60%	Version 4.2 Baseline
78.27%	19.75%	8.99%	No error term
80.06%	47.66%	22.45%	No IR tuning
75.49%	18.46%	8.79%	No IR tuning/No error term

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
January 25, 2003



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78.27%	19.75%	8.99%	No error term
80.06%	47.66%	22.45%	No IR tuning
75.49%	18.46%	8.79%	No IR tuning/No error term

SUMMARY

In Version 4.2

Results degrade compared to ECMWF if all IR tuning is removed

Results improve if 4 μm tuning coefficients are doubled

Results degrade if $\overline{N}_{ii}$ is set equal to zero

However

Findings may be due to artifacts in the retrieval system as is

More research is needed to eliminate or minimize tuning and "physics error" terms

This must be done before we can set these coefficients to zero without degrading results